

Hip/Lower Extremity Fracture

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Introduction

A hip or lower extremity fracture would be unlikely to occur in the microgravity environment. Exceptions could include stress fractures incurred during regular exercise, crush fracture by being caught between two large masses during spaceflight, or a fall during a planetary surface Extravehicular Activity ([EVA](#)). Fractures could also be caused by hard landing on return to Earth. Space flight associated bone loss, commonly seen in long duration crewmembers, may lower the forces necessary to cause a fracture. However, in more than 40 years of short duration space flight experience, no fractures have occurred during a mission.^[1] The current medical kits onboard the International Space Station ([ISS](#)) include immobilization splints, dressings, and pain control medications.

Clinical Priority and Clinical Priority Rationale by Design Reference Mission

One of the inherent properties of space flight is a limitation in available mass, power, and volume within the space craft. These limitations mandate prioritization of what medical equipment and consumables are manifested for the flight, and which medical conditions would be addressed. Therefore, clinical priorities have been assigned to describe which medical conditions will be allocated resources for diagnosis and treatment. “Shall” conditions are those for which diagnostic and treatment capability must be provided, due to a high likelihood of their occurrence and severe consequence if the condition were to occur and no treatment was available. “Should” conditions are those for which diagnostic and treatment capability should be provided if mass/power/volume limitations allow. Conditions were designated as “Not Addressed” if no specific diagnostic and/or treatment capability are expected to be manifested, either due to a very low likelihood of occurrence or other limitations (for example, in medical training, hardware, or consumables) that would preclude treatment. Design Reference Missions (DRMs) are proposed future missions designated by a set of assumptions that encompass parameters such as destination, length of mission, number of crewmembers, number of Extravehicular Activities ([EVAs](#)), and anticipated level of

care. The clinical priorities for all medical conditions on the Exploration Medical Condition List (EMCL) can be found here (https://humanresearchwiki.jsc.nasa.gov/index.php?title=Category:All_DRM). The EMCL document may be accessed here (https://humanresearchwiki.jsc.nasa.gov/images/6/62/EMCL_RevC_2013.pdf).

Design Reference Mission	Clinical Priority	Clinical Priority Rationale
<p>Lunar sortie mission</p> <p>Assumptions:</p> <ul style="list-style-type: none"> 4 crewmembers (3 males, 1 female) 14 days total 4 EVAs/ crewmember <u>Level of Care 3</u> 	Not Addressed	Under nominal conditions, crewmembers in the microgravity environment of the Moon, either inside a lunar habitat or outside on an EVA, will be unlikely to sustain anything more than minor musculoskeletal trauma or strain. The reduced gravity is thought to be protective in that forces will be minimized and the pressurized EVA suit is expected to offer some additional protection. Minor injuries are addressed under the category of Extremity Sprains/Strains.
<p>Lunar outpost mission</p> <p>Assumptions:</p> <ul style="list-style-type: none"> 4 crewmembers (3 males, 1 female) 180 days total 90 EVAs/ crewmember <u>Level of Care 4</u> 	Not Addressed	Under nominal conditions, crewmembers in the microgravity environment of the Moon, either inside a lunar habitat or outside on an EVA, will be unlikely to sustain anything more than minor musculoskeletal trauma or strain. The reduced gravity is thought to be protective in that forces will be minimized and the pressurized EVA suit is expected to offer some additional protection. Minor injuries are addressed under the category of Extremity Sprains/Strains.
<p>Near-Earth Asteroid (NEA) mission</p> <p>Assumptions:</p> <ul style="list-style-type: none"> 3 crewmembers (2 males, 1 female) 395 days total 30 EVAs/ crewmember <u>Level of Care 5</u> 	Not Addressed	Under nominal conditions, crewmembers in the microgravity environment of the exploration spacecraft and the asteroid's surface will be unlikely to sustain anything more than minor musculoskeletal trauma or strain. The reduced gravity is thought to be protective in that forces will be minimized and the pressurized EVA suit is expected to offer some additional protection. Minor injuries are addressed under the category of Extremity Sprains/Strains.

Initial Treatment Steps During Space Flight

A link is provided to a prior version of the International Space Station (ISS) Medical Checklist, which outlines the initial diagnostic and treatment steps recommended during space flight for various conditions which may be encountered onboard the ISS. Further diagnostic and treatment procedures beyond the initial steps outlined in the Medical Checklist are then recommended by the ground-based Flight Surgeon, depending on the clinical scenario.

Please note that this version does not represent current diagnostic or treatment capabilities available on the ISS. While more recent versions of this document are not accessible to the general public, the provided version of the checklist can still provide a general sense of how medical conditions are handled in the space flight environment. Medical Checklists will be developed for exploration missions at a later point in time.

Please note this file is over 20 megabytes (MB) in size, and may take a few minutes to fully download.

ISS Medical Checklist (http://www.nasa.gov/centers/johnson/pdf/163533main_ISS_Med_CL.pdf)

Capabilities Needed for Diagnosis

The following is a hypothetical list of capabilities that would be helpful in diagnosis. It does not necessarily represent the current capabilities available onboard current spacecraft or on the ISS, and may include capabilities that are not yet feasible in the space flight environment.

- Vital signs measurement capability (blood pressure, pulse, respiratory rate, temperature, pulse oximetry)
- Auscultation device (such as a stethoscope)
- Doppler (assessment of distal pulse)
- Imaging (such as X-rays, Ultrasound, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), bone scan)

Capabilities Needed for Treatment

The following is a hypothetical list of capabilities that would be helpful in treatment. It does not necessarily represent the current capabilities available onboard current spacecraft or on the ISS, and may include capabilities that are not yet feasible in the space flight environment.

- Crew medical restraint system
- Abduction pillow (for comfort measures)
- Cold pack
- Analgesics (non-narcotic, narcotic, oral, injectable)
- Sharps container
- Immobilization devices (such as splints, casting material, etc.)
- Non-sterile gloves
- Skin cleanser (such as alcohol/Benzalkonium antiseptic (BZK)/iodine)
- Traction device
- Blood products

Associated Gap Reports

The NASA Human Research Program (HRP) identifies gaps in knowledge about the health risks associated with human space travel and the ability to mitigate such risks. The overall objective is to identify gaps critical to human space missions and close them through research and development. The gap reports that are applicable to this medical condition are listed below. A link to all of the HRP gaps can be found here (<http://humanresearchroadmap.nasa.gov/Gaps/>).

- 2.01 - We do not know the quantified health and mission outcomes due to medical events during exploration missions.
- 2.02 - We do not know how the inclusion of a physician crew medical officer quantitatively impacts clinical outcomes during exploration missions.
- 3.01 - We do not know the optimal training methods for in-flight medical conditions identified on the Exploration Medical Condition List taking into account the crew medical officer's clinical background. (Closed)
- 3.03 - We do not know which emerging technologies are suitable for in-flight screening, diagnosis, and treatment during exploration missions.
- 4.01 - We do not have the capability to provide a guided medical procedure system that integrates with the medical system during exploration missions.
- 4.02 - We do not have the capability to provide non-invasive medical imaging during exploration missions.
- 4.05 - We do not have the capability to measure laboratory analytes in a minimally invasive manner during exploration missions.
- 4.06 - We do not have the capability to stabilize bone fractures and accelerate fracture healing during exploration missions.
- 4.07 - Limited wound care capability to improve healing following wound closure (Closed)
- 4.08 - We do not have the capability to optimally treat musculoskeletal injuries during exploration missions.
- 4.12 - We do not have the capability to generate and utilize sterile intravenous fluid from potable water during exploration missions.
- 4.14 - We do not have the capability to track medical inventory in a manner that integrates securely with the medical system during exploration missions.
- 4.15 - Lack of medication usage tracking system that includes automatic time stamping and crew identification
- 4.17 - We do not have the capability to package medications to preserve stability and shelf-life during exploration missions.
- 4.19 - We do not have the capability to monitor physiological parameters in a minimally invasive manner during exploration missions.
- 4.23 - We do not have the capability to auscultate, transmit, and record body sounds during exploration missions.
- 4.24 - Lack of knowledge regarding the treatment of conditions on the Space Medicine Exploration Medical Condition List in remote, resource poor environments (Closed)
- 4.27 - We do not have the capability to sterilize medical equipment during exploration missions.
- 5.01 - We do not have the capability to comprehensively manage medical data during exploration missions.

Other Pertinent Documents

List of Acronyms

B	
BZK	Benzalkonium Antiseptic
C	
CT	Computed Tomography
D	

DRM	Design Reference Mission
E	
EMCL	Exploration Medical Condition List
EVA	Extravehicular Activity
H	
HRP	Human Research Program
I	
ISS	International Space Station
IV	Intravenous
M	
MB	Megabyte
MRI	Magnetic Resonance Imaging
N	
NASA	National Aeronautics and Space Administration
NEA	Near Earth Asteroid

References

1. Sibonga J, Jones JA, Myers J, Lewandowski B, Lang T, Keyak J. Evidence Book Risk of Bone Fracture. Houston: NASA - HRP; 2008 Mar. Report No.: HRP-47060.

Last Update

This topic was last updated on 8/12/2014 (Version 2).

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